US-PAT-NO: 6429097

DOCUMENT-IDENTIFIER: US 6429097 B1

TITLE: Method to sputter silicon films

---------- KWIC ---------

In the fabrication of thin film (TF) IC devices, such as thin film transistors
(TFTs), a method and apparatus is needed to form the various layers
constituting the device. Silicon material, typically amorphous silicon (a-Si)
or polysilicon, are used for the active layers of the device and silicon-based
insulating layers, typically silicon nitride, SiN.sub.x, or silicon oxide,
SiO.sub.x, are typically used as insulators between the active layers. There
are several methods to deposit these films. Some methods rely on chemical
reactions between one or more suitable gas-phase species to deposit the
silicon-based film on the substrate where TF devices are to be fabricated.
These reactions require energy, which may be supplied in the form of thermal
energy, such as chemical vapor deposition (CVD), plasma energy, such as
plasma-enhanced CVD (PE-CVD). photon energy, such as photo-enhanced, or
laser-pyrolysis CVD, or the presence of a **catalyst,** as in the case of hot-wire
CVD.

The following describes a method of sputtering, or **physical vapor deposition**
(PVD), for deposition of active layers, such as **amorphous silicon** (a-Si) and
polysilicon, and deposition of insulating layers, such as SiO.sub.x &
SiN.sub.x, and an apparatus for practicing the method of the invention. These

thin-films are used in the fabrication of thin film devices, such as thin film transistors (TFTs), which are most frequently used in liquid crystal displays (LCDs), and the invention will be described using TFT construction as an example. One of ordinary skill in the art will appreciated that the method and apparatus of the invention may be used to fabricate other types of TF semiconductor devices.

There are some cases where the retardation of the nucleation and crystalline growth in the silicon film are considered positive effects. One example involves the introduction of a **catalyst** material, such as nickel, at specified locations into the silicon film, to promote nuclei formation and crystalline growth from these preferred locations. This is achieved by subjecting the silicon film to a thermal annealing cycle, thereby enabling the phase transformation from a-Si to polysilicon at low temperatures via the use of the **catalyst**. To improve the crystalline quality and its uniformity, it is important to suppress nucleation and crystalline growth in silicon material void of the **catalyst**. The way to achieve this is to utilize silicon material that is particularly difficult to crystallize without an added **catalyst**. Such material may be sputtered silicon with a specified Ar content which is high enough to suppress partial solid-phase crystallization of silicon material void of **catalyst**. Hence, from this point of view we define the appropriate Ar content in the range of: 2.multidot.10.sup.18 at/cm.sup.3 <Ar<2.multidot.10.sup.20 at/cm.sup.3.

As previously described, excimer laser anneal (ELA) may be used to convert an a-Si layer to a polysilicon layer. FIG. 5 shows the Ar content in sputtered silicon films before and after exposure to excimer laser

anneal (ELA) process.
Regions of data points are shown for Ar content with pre-anneal and with ELA, 70, and without ELA, 72; without pre-anneal and with ELA, 74, and without ELA, 76. The exposure to ELA, regions 70, 74, results in a reduction in the Ar content in the post-ELA films of more than an order of magnitude, with respect to pre-ELA films. In contrast to ELA, subjecting the films to a thermal anneal at 450.degree. C. for three hours in nitrogen ambient produces no effect at all in the Ar content. Hence, polysilicon films, produced by ELA of **PVD** **amorphous silicon** films, tend to contain Ar at a concentration of about 1-2.multidot.10.sup.19 at/cm.sup.3 or less. Thus, the ELA process is another way to affect the concentration of Ar in **PVD**-Si films. This is an important feature of the process, because, when the Ar content is required to be initially high to suppress partial crystallization, it may subsequently be reduced by applying ELA process, so that the quality of the film is improved by effectively decreasing its Ar content.

	Type	L #	Hits	Search Text	DBs	Time Stamp
1	BRS	L1	4	(anneal or annealing or annealed) adj10 (amorphous adj3 silicon) adj10 catalyst	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/10/03 08:25
2	BRS	L2	0	1 and (PVD or (physical adj3 vapor adj3 deposition))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/10/03 08:26
3	BRS	L3	200	(amorphous adj3 silicon) same (PVD or (physical adj3 vapor adj3 deposition))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/10/03 08:27
4	BRS	L4	14	3 and (catalyst or catalysts)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/10/03 08:27

US-PAT-NO: 5985704

DOCUMENT-IDENTIFIER: US 5985704 A

TITLE: Method for manufacturing a semiconductor device

---------- KWIC ---------

Referring to FIGS. 2A-2E, a blocking layer 22 comprising silicon oxide was initially formed on a substrate 21 and then an **amorphous silicon** layer 23 was deposited by known method. Then, a protective layer 24 of the present invention such as silicon oxide, silicon nitride or the like was formed by **physical vapor deposition** (e.g. sputtering) or a chemical vapor deposition (e.g. plasma CVD, photo CVD).

forming a crystallized semiconductor film comprising silicon containing a **catalyst** metal for promoting crystallization of said semiconductor film on an insulating surface of a substrate;

forming a layer in contact with said amorphous semiconductor film which contains a **catalyst** metal for promoting crystallization of said semiconductor film;

disposing a **catalyst** capable of promoting crystallization of said semiconductor layer in contact with said semiconductor layer;

crystallizing said semiconductor layer with the aid of said **catalyst**;

disposing a **catalyst** metal containing material in contact with said non-single crystalline semiconductor layer;

crystallizing said semiconductor layer with said **catalyst** metal containing material;

18. The method of claim 1 wherein said **catalyst** metal is at least one selected from the group consisting of Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, Sc, Ti, V, Cr, Mn, Cu, Zn, Au and Ag.

19. The method of claim 3 wherein said **catalyst** metal is at least one selected from the group consisting of Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, Sc, Ti, V, Cr, Mn, Cu, Zn, Au and Ag.

20. The method of claim 6 wherein said **catalyst** comprises at least a metal selected from the group consisting of Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, Sc, Ti, V, Cr, Mn, Cu, Zn, Au and Ag.

21. The method of claim 12 wherein said **catalyst** metal is at least one selected from the group consisting of Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, Sc, Ti, V, Cr, Mn, Cu, Zn, Au and Ag.

disposing a **catalyst** containing material in contact with said semiconductor film, said **catalyst** capable of promoting a crystallization of silicon;

crystallizing said semiconductor film with the aid of said **catalyst**;

25. The method of claim 22 wherein said **catalyst** metal is at least one selected from the group consisting of Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, Sc, Ti, V, Cr, Mn, Cu, Zn, Au and Ag.

disposing a **catalyst** containing material in contact with said semiconductor film, said **catalyst** capable of promoting a crystallization of silicon;

crystallizing said semiconductor film with the aid of said **catalyst** by heating;

29. The method of claim 26 wherein said **catalyst** metal is at least one
selected from the group consisting of Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, Sc,
Ti, V, Cr, Mn, Cu, Zn, Au and Ag.

	Type	L #	Hits	Search Text	DBs
1	BRS	L3	434	((amorphous near2 silicon) or a-si) same ("physical vapor deposition" or PVD)	USPAT; US-PGPUB
2	BRS	L6	15	3 and catalyst	USPAT; US-PGPUB
3	IS&R	L7	624	(438/166).CCLS.	USPAT; US-PGPUB
4	IS&R	L8	241	(438/482).CCLS.	USPAT; US-PGPUB
5	IS&R	L9	375	(438/486).CCLS.	USPAT; US-PGPUB
6	IS&R	L10	783	(438/149).CCLS.	USPAT; US-PGPUB

	Type	Hits	Search Text
1	BRS	18121	"physical vapor deposition" or PVD
2	BRS	265	("physical vapor deposition" or PVD) same (a-si or "amorphous silicon" or asi)
3	BRS	0	(("physical vapor deposition" or PVD) near8 (a-si or "amorphous silicon" or asi)) same "metal catalyst"
4	BRS	87	("physical vapor deposition" or PVD) near8 (a-si or "amorphous silicon" or asi)
5	BRS	33	(("physical vapor deposition" or PVD) near8 (a-si or "amorphous silicon" or asi)) same (anneal$4 or crystalliz$4 or laser$4 or heat$4)
6	BRS	138	((amorphous near2 silicon) or asi or a-si) with ((physical near2 vapor near2 deposition) or PVD)
7	BRS	105	(((amorphous near2 silicon) or asi or a-si) with ((physical near2 vapor near2 deposition) or PVD)) not ((("physical vapor deposition" or PVD) near8 (a-si or "amorphous silicon" or asi)) same (anneal$4 or crystalliz$4 or laser$4 or heat$4))
8	BRS	51	((((amorphous near2 silicon) or asi or a-si) with ((physical near2 vapor near2 deposition) or PVD)) not ((("physical vapor deposition" or PVD) near8 (a-si or "amorphous silicon" or asi)) same (anneal$4 or crystalliz$4 or laser$4 or heat$4))) not (("physical vapor deposition" or PVD) near8 (a-si or "amorphous silicon" or asi))
9	IS&R	786	(438/149).CCLS.
10	IS&R	625	(438/166).CCLS.
11	IS&R	697	(438/482).CCLS.
12	IS&R	375	(438/486).CCLS.

	DBs	Time Stamp
1	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:06
2	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:07
3	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:07
4	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:14
5	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:53
6	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:45
7	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:45
8	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:45
9	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:53
10	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:53
11	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:53
12	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:53

	Typ	Hits	Search Text
13	BRS	6	((438/149).CCLS.) and (("physical vapor deposition" or PVD) same (a-si or "amorphous silicon" or asi))
14	BRS	21	((438/166).CCLS.) and (("physical vapor deposition" or PVD) same (a-si or "amorphous silicon" or asi))
15	BRS	5	((438/482).CCLS.) and (("physical vapor deposition" or PVD) same (a-si or "amorphous silicon" or asi))
16	BRS	9	((438/486).CCLS.) and (("physical vapor deposition" or PVD) same (a-si or "amorphous silicon" or asi))

	DBs	Time Stamp
13	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:59
14	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:59
15	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:59
16	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/07/25 13:59